CHM129

Manipulations of the Equilibrium Constant

1. Predict the equilibrium constant for:

$CO_{2\,(g)} + 3\ H_{2\,(g)} \leftrightarrow CH_3OH_{\,(g)} + H_2O_{\,(g)}$ **$K_1 = ?$**

given the equilibrium constants for the following reactions.

$CO_{\,(g)} + H_2O_{\,(g)} \leftrightarrow CO_{2\,(g)} + H_{2\,(g)}$ $K_2 = 1.0 \times 10^5$

$CO_{\,(g)} + 2\ H_{2\,(g)} \leftrightarrow CH_3OH_{\,(g)}$ $K_3 = 1.4 \times 10^7$

$CO_{2(g)} + H_{2(g)} \rightleftharpoons CO_{(g)} + H_2O_{(g)}$ $K = \frac{1}{1.0 \times 10^5}$

$CO_{(g)} + 2H_{2(g)} \rightleftharpoons CH_3OH_{(g)}$ $K = 1.4 \times 10^7$

$CO_{2(g)} + 3\ H_{2(g)} \rightleftharpoons CH_3OH_{(g)} + H_2O_{(g)}$

$K = \left(\frac{1}{1.0 \times 10^5}\right)(1.4 \times 10^7) = 140$

2. Consider the following chemical equation and equilibrium constant at 25 °C.

$2\ COF_{2\,(g)} \leftrightarrow CO_{2\,(g)} + CF_{4\,(g)}$ $K_c = 2.2 \times 10^6$

Compute the equilibrium constant for the following reaction at 25°C.

$2\ CO_{2\,(g)} + 2\ CF_{4\,(g)} \leftrightarrow 4\ COF_{2\,(g)}$ **$K' = ?$**

$CO_{2(g)} + CF_{4(g)} \rightleftharpoons 2COF_{2(g)}$ $K = \frac{1}{2.2 \times 10^6}$

$2CO_{2(g)} + 2CF_4 \rightleftharpoons 4COF_{2(g)}$

$K = \left(\frac{1}{2.2 \times 10^6}\right)^2 = 2.1 \times 10^{-13}$

3. Find K_c for the following reaction:

$$N_{2\,(g)} + O_{2\,(g)} + Br_{2\,(g)} \leftrightarrow 2NOBr_{\,(g)} \qquad K_c = ?$$

Use the following data to find K_c:

$2NO_{(g)} \leftrightarrow N_{2(g)} + O_{2(g)} \quad K_c = 2.1 \times 10^{30}$

$NO_{(g)} + \frac{1}{2}Br_{2(g)} \leftrightarrow NOBr \quad K_c = 1.41$

$$N_{2(g)} + O_{2(g)} \rightleftharpoons 2\,NO_{(g)} \qquad K = \frac{1}{2.1 \times 10^{30}}$$

$$2\left(NO_{(g)} + \tfrac{1}{2}Br_{2(g)} \rightleftharpoons NOBr_{(g)}\right) \qquad K = (1.41)^2$$

$$N_{2(g)} + O_{2(g)} + Br_{2(g)} \rightleftharpoons 2\,NOBr_{(g)}$$

$$K = \left(\frac{1}{2.1 \times 10^{30}}\right)(1.41)^2 = 9.5 \times 10^{-31}$$